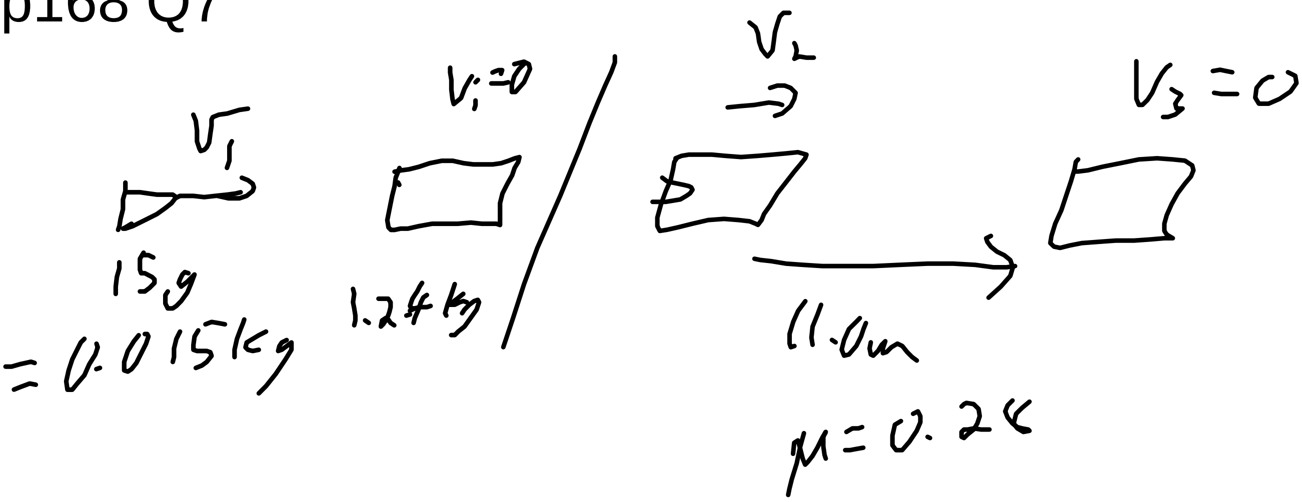
p168 Q7



inelastic collision (stick together) kinetic energy is lost
collision - think conservation of momentum

$$\Sigma p_i = \Sigma p_f$$

$$m_B v_B + \cancelto{0}{m_w v_w} = (m_B + m_w) v_{Bw}$$

in the slide

$$F_f = \mu m g$$

$$\Delta E_k = W_{net} = Fd$$

$$\frac{1}{2} \cancel{m_{Bw}} v_{Bw}^2 = \mu m g d$$

$$v_{Bw} = \sqrt{2(0.28)(9.8)(11)}$$

$$= 7.7697 \text{ m/s}$$

$$0.015\,kg\, v_1 = (0.015\,kg + 1.24\,kg)\, 7.7697$$

$$0.015\,kg\,V_B = (0.015\,kg + 1.24\,kg)\,7.7697\,m/s$$

$$\boxed{V_B = 650\,m/s}$$

Notes:

2-D momentum problems

Like all vector problems, you can solve using

1. scale vector diagrams (not that precise)
2. components
3. cosine/sine law

Sample problems:

1. A 10.0 kg bomb explodes into 3 pieces. One piece flies North at 12.0m/s and is 3.0 kg One piece flies East and is 4.0 kg at 8.0 m/s. What is the magnitude and direction of the velocity of the third piece?
2. You play pool with a 0.80kg cue ball moving at 2.0 m/s. It collides with a target ball 0.40 kg at rest. What is the velocity of the cue ball after the collision if the target ball moves off at 1.0 m/s at 30.0º to the initial motion of the cue ball? Was the collision elastic? Show work for marks. What was the impulse on each ball?

   Bring your labbook next class

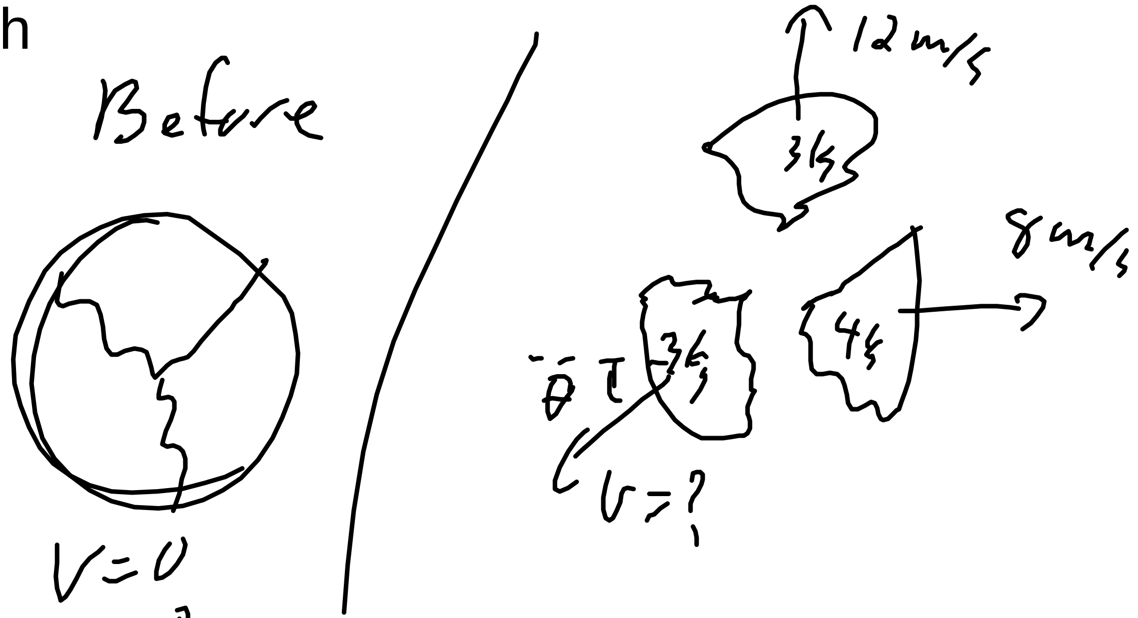
   Read the lab p19 Method 1

p169 Q16, 17, 25, 27, 29, 31, 33

impulse = $\Delta p = F_{net}\Delta t$ = area under the Fnet-t graph

Before

1



$v = 0$

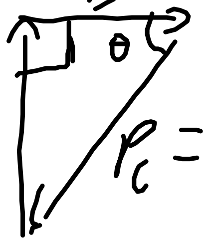
$p = 0$

$$\Sigma p_i = \Sigma p_f$$

$$0 = \text{vector sum} = 0$$

$p_B = 4 \times 8 = 32 \text{ kg m/s}$

$p_A = 3 \times 12 = 36 \text{ kg m/s}$



$p_C = ?$ $\sqrt{36^2 + 32^2} = 48.2 \text{ kg m/s}$

add to zero

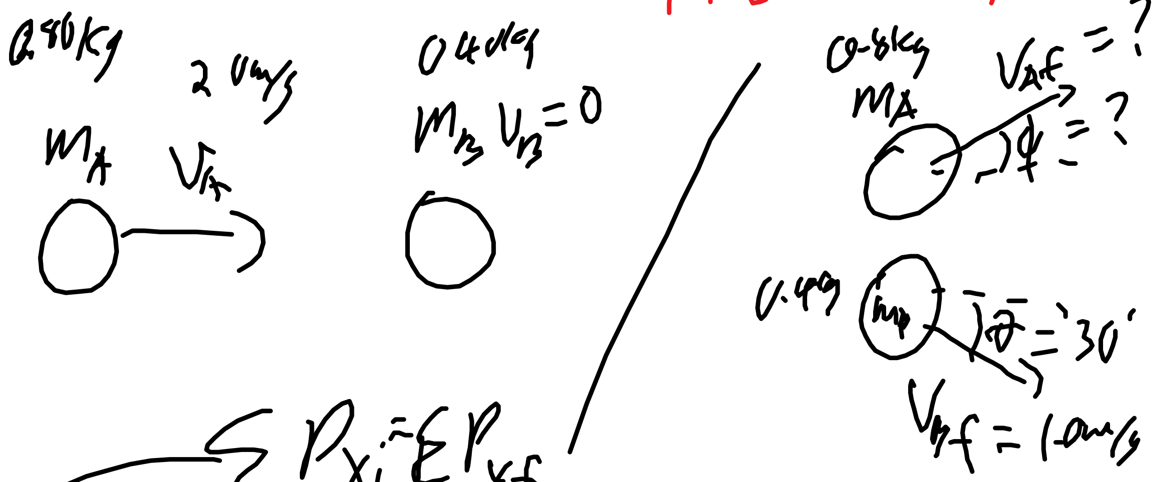
$p = mv$ $\quad v = \dfrac{48.2 \text{ kg m/s}}{3 \text{ kg}}$

$$\boxed{\begin{array}{l} v = 16.1 \text{ m/s} \\ \theta = 48.4^\circ \text{ South of West} \end{array}}$$

$\tan\theta = \dfrac{36}{32}$

or 41.6° w of S

2



$$\Sigma P_{xi} = \Sigma P_{xf}$$

$$\Sigma P_{yi} = \Sigma P_{yf}$$

x $\rightarrow$ $$m_A V_A + 0 = m_A V_{Afx} + m_B V_{Bf} \cos\theta$$

$$0.80(2.0) = 0.8\, V_{Afx} + 0.4(1)\cos 30$$

$$1.6 - 0.346 = 0.8\, V_{Afx}$$

$$V_{Afx} = 1.567 \text{ m/s}$$

y: $$0 = m_A V_{Afy} + m_B V_{Bf} \sin\theta$$

$$0 = 0.8\, V_{Afy} + 0.4(1)\sin 30°$$

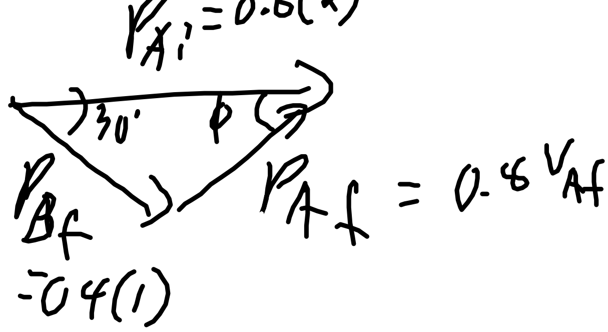
$$V_{Afy} = 0.25 \text{ m/s}$$

$$V_{Af} = \sqrt{V_{Afx}^2 + V_{Afy}^2} = \boxed{1.59 \text{ m/s}}$$

$$\phi = \tan^{-1}\frac{0.25}{1.567} = \boxed{9.1°}$$

$$\phi = \tan^{-1}\frac{0.25}{1.567} = \boxed{9.1^\circ}$$

Alternate solution



Cosine Law
$$p_{Af}^2 = 0.4^2 + 1.6^2 - 2(0.4)(1.6)\cos 30^\circ$$

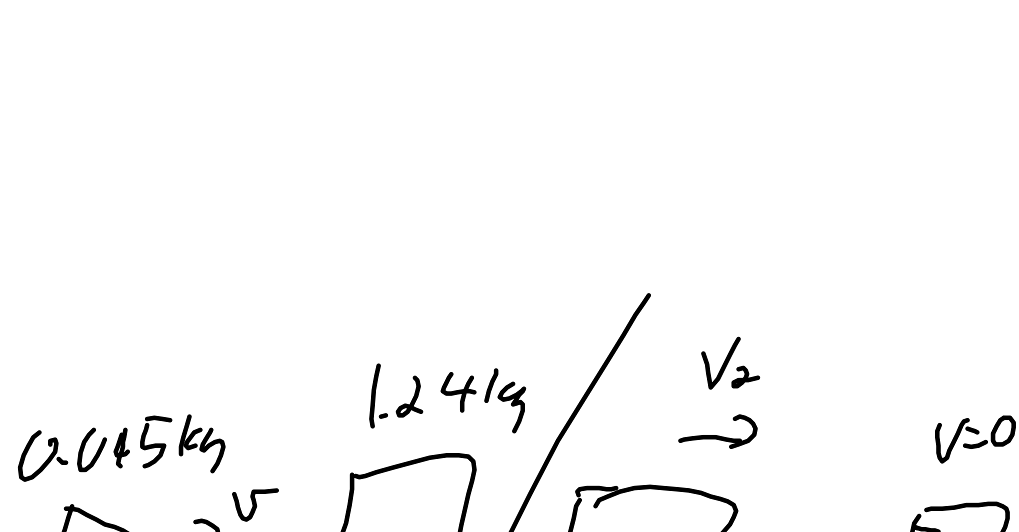
$$p_{Af} = 1.269$$

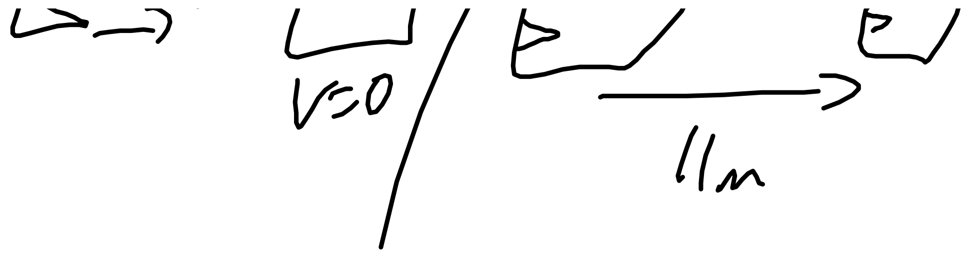
$$\boxed{v_{Af} = 1.59\ \text{m/s}}$$

$$\frac{\sin\phi}{0.4} = \frac{\sin 30}{1.269} \qquad \boxed{\phi = 9.1^\circ}$$

p167

Q7





If stuff sticks together in a collision, it is inelastic - some energy is lost.
Think momentum is conserved not kinetic energy.

total momentum initial = total momentum final
$mv + 0 = (m+M)v_2$

how do we find v_2?
the kinetic energy of the block is lost to work done by friction on the table
$\Delta E_k = W_{net} = F_f d = \mu(M+m)gd = 1/2\ (M+m){v_2}^2$
$v_2 = \text{sqrt}(2x0.28x9.8x11)=7.769684678286501$
$mv + 0 = (m+M)v_2$
$0.015v=(0.015+1.24)(7.7697)$
$v= (0.015+1.24)x7.76968467828650/0.015=$
650.0636180833036
$\boxed{650m/s}$

answer at the back of the book is wrong

2-D momentum problems

solve them like any other vector problem

1. scale vector addition diagram (not precise)
2. components - break into x and y components

conservation of momentum separately
$\sum p_{xi}=\sum p_{xf}$ and $\sum p_{yi}=\sum p_{yf}$

3. Trig - cosine/sine law

Sample problems:

1. A 10.0 kg bomb explodes into 3 pieces. One piece flies North at 12.0m/s and is 3.0 kg. One piece flies East and is 4.0 kg at 8.0 m/s. What is the magnitude and direction of the velocity of the third piece?
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   What was the impulse on each ball?
   Bring your labbook next class
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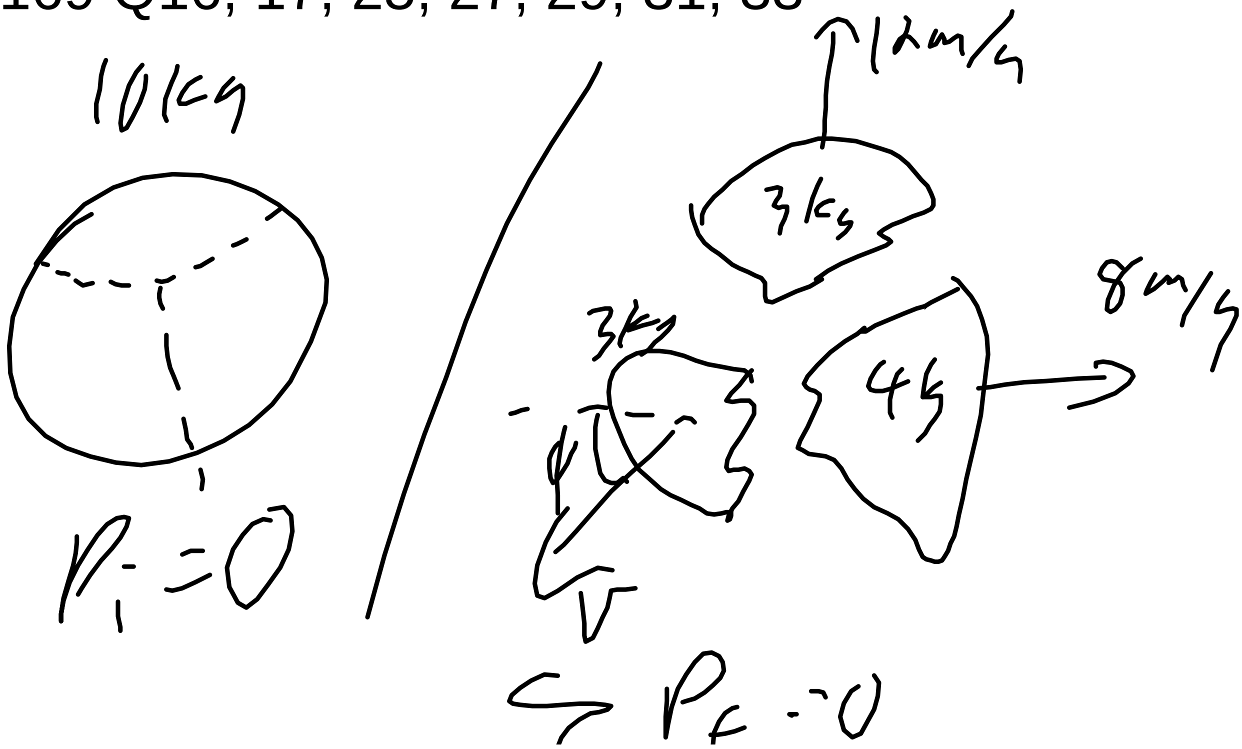
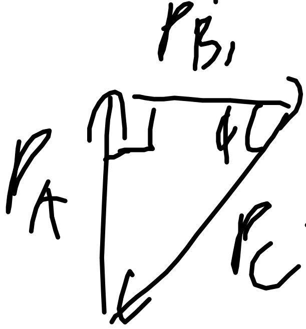


vector sum diagram



$p_C = \sqrt{p_A^2 + p_B^2}$

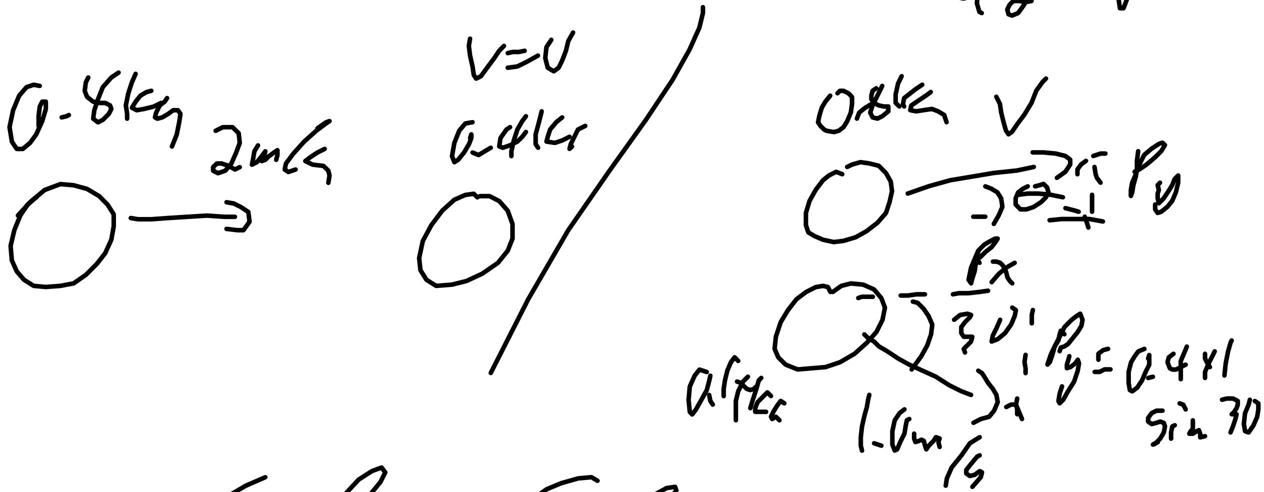
$= \sqrt{[3(12)]^2 + [4(8)]^2}$

$p_C = 48.2 \text{ kg m/s}$

$v = \frac{p}{m} = \boxed{16.1 \text{ m/s}}$

$\phi = \tan^{-1}\left(\frac{36}{32}\right) = \boxed{48^\circ \text{ S of W}}$

42° W of S



$\Sigma p_{yi} = \Sigma p_{yf}$

$0 = 0.4 \sin 30 + p_y$

y $\quad 0 = \ldots$

$P_y = 0.20\,\text{kgm/s}$ up.

$x \quad 0.8 \times 2 + 0 = P_x + 0.4 \times 1 \times 8 \cos 30°$

$P_x = 1.6 - \ldots$

$= 1.2535\,\text{kgm/s}$

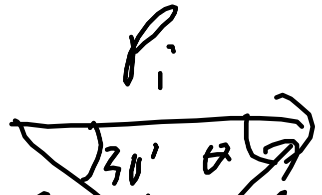
$$P = \sqrt{1.2535^2 + 0.2^2} = 1.2694$$

$$v = \frac{P}{m} = 1.59\,\text{m/s}$$

$$\theta = \tan^{-1} \frac{0.2}{1.2535} = \boxed{9.1°}$$

to initial motion - see diagram

Alternate Solution



$$P^2 = 1.6^2 + 0.4^2 - 2(1.6)(0.4)\cos 30°$$

$$P = 1.2535$$

$$\boxed{v = 1.59 m/s}$$

$$\frac{\sin\theta}{0.4} = \frac{\sin 30°}{1.2533} \quad \boxed{\theta = 9.1°}$$

elastic $\frac{1}{2} m v^2 \overset{?}{=} \frac{1}{2} m_A v_A^2 + \frac{1}{2} m_B v_B^2$

$$\frac{1}{2}(0.8)(2)^2 \overset{?}{=} \frac{1}{2}(0.8)(1.59)^2 + \frac{1}{2}(0.4)(1)^2$$

$$1.6 J \overset{?}{=} 1.0 J + 0.2 J$$

not equal, 0.4 J is lost

impulse $\Delta \vec{p} = \vec{p}_f \ominus \vec{p}_i$ vector

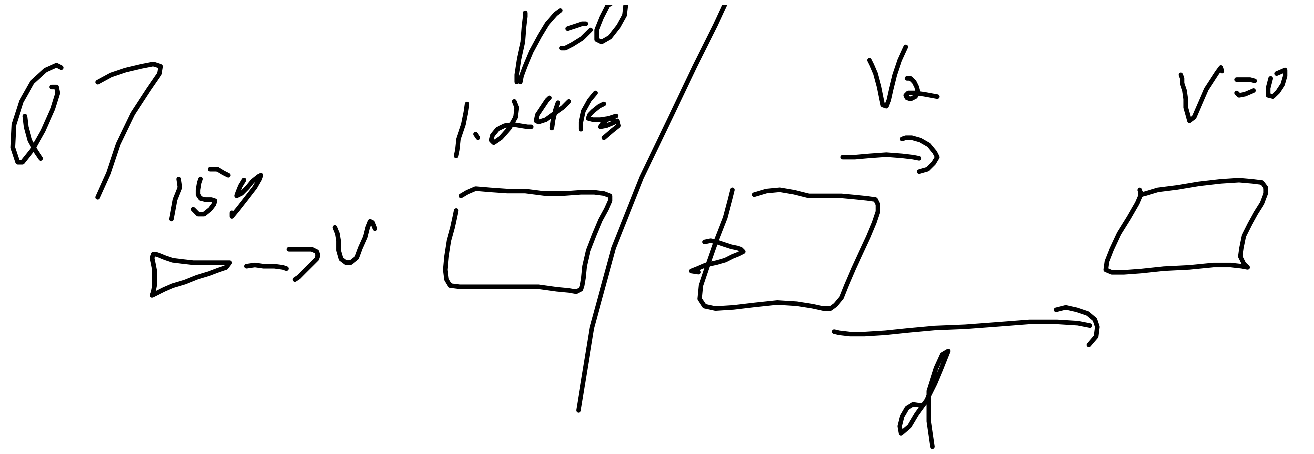
$\Delta p = (0.4 kg)(1 m/s) = 0.4 kg\,m/s$ at 30 to initial motion

p 168

$V = 0$

V_2

$V = 0$

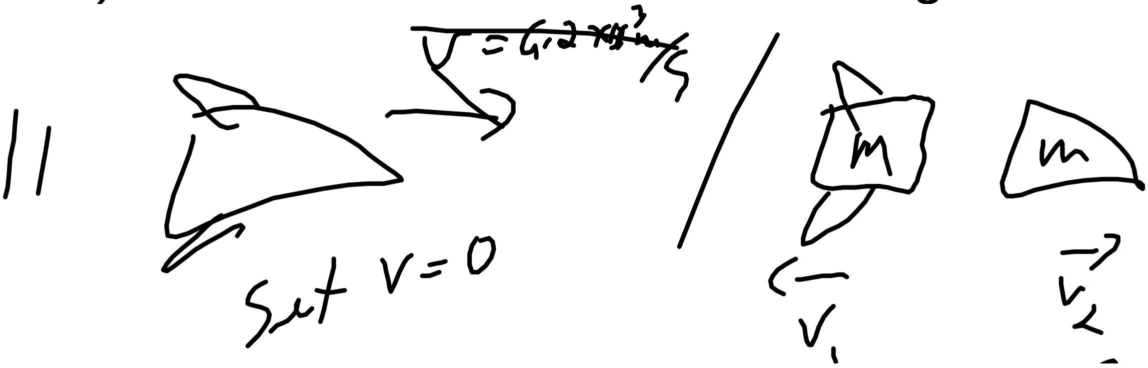


Collision or explosion - think momentum is conserved
kinetic energy is only conserved in perfectly elastic collisions. Otherwise, lots of the kinetic energy is lost as heat/sound/deformation.

big idea:
$P_i=P_f$ for the collision $mv=(m+M)v_2$
$\Delta Ek=W$ for the slide $1/2(m+M){v_2}^2=Fd=\mu(m+M)gd$

v_2 = sqrt(2x0.28x9.8x11)=7.769684678286501

$mv=(m+M)v_2$
0.015v=(0.015+1.24)x7.769684678286501=
v = (0.015+1.24)x7.769684678286501/0.015=
650.0636180833036
650m/s answer at the back of the book is wrong (640) but the detailed answers are right



$V_1 + V_2 = 2.45 \times 10^3 \, m/s$

$V = 1.225 \times 10^3 \, m/s$

$V_1 = 6.2 \times 10^3 \, m/s - 1.225 \times 10^3 \, m/s$

$= 5.0 \times 10^3 \, m/s$

$V_2 = 7.4 \times 10^3 \, m/s$

b) $E_{k_i} \stackrel{?}{=} E_{k_f}$

$\frac{1}{2}(700\,kg)(6.2 \times 10^3)^2 \stackrel{?}{=} \frac{1}{2}(350)(5 \times 10^3)^2 + \frac{1}{2}(350)(7.4 \times 10^3)^2$

Notes:

p=mv

impulse = $\Delta p = F_{net}\Delta t$ = area under F_{net} - t graph

momentum is conserved in collisions and explosions if no external forces.

This applies in 2-D problems as well.

solve using

1. Scale vector diagram (not precise)
2. vector components -
   momentum is conserved then it is conserved in each component

$\sum p_{xi} = \sum p_{xf}$ and $\sum p_{yi} = \sum p_{yf}$

3. Cosine/Sine Laws

Sample problems:

1. A 10.0 kg bomb explodes into 3 pieces. One piece flies North at 12.0m/s and is 3.0 kg. One piece flies East and is 4.0 kg at 8.0 m/s. What is the magnitude and direction of the velocity of the third piece?
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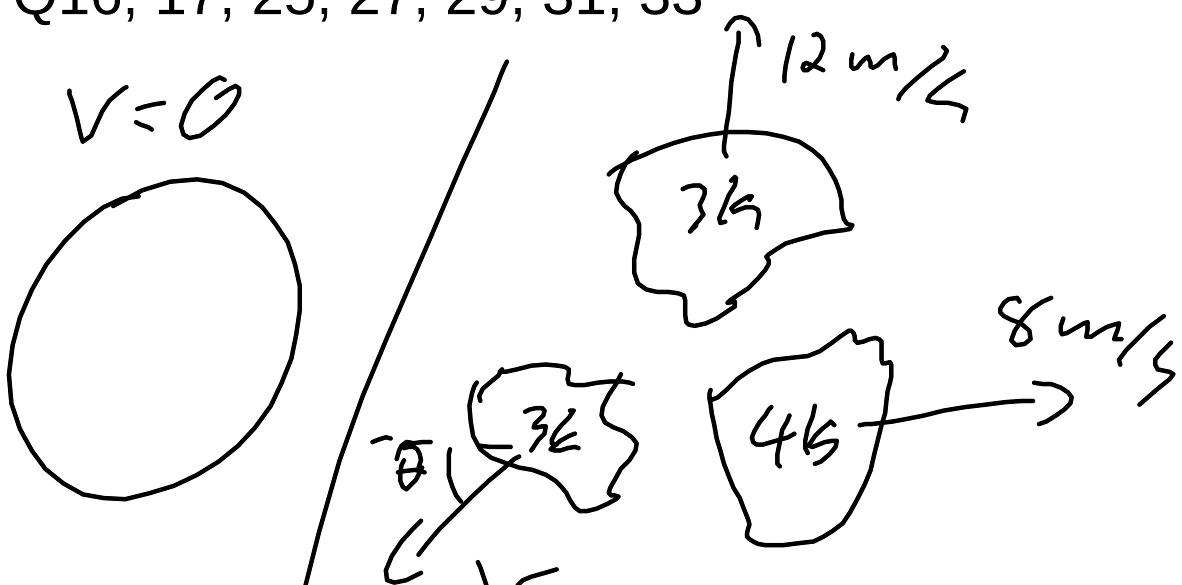
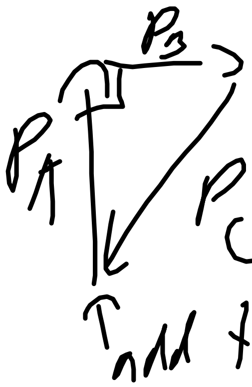


$\sum p_i = \sum p_f$

$\Sigma P_i = \Sigma P_f$ ← vector

0



$P_C = \sqrt{P_A^2 + P_B^2}$

$$P_C = \sqrt{(3\times 12)^2 + (4\times 8)^2}$$

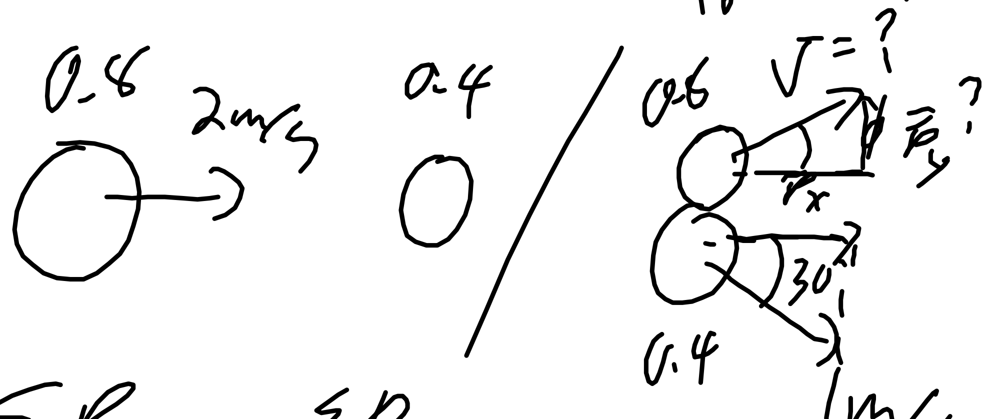
$$P_C = 48.17 \text{ kg m/s}$$

$$v = \frac{P}{m} = \frac{48.17}{3\text{ kg}} = \boxed{16 \text{ m/s}}$$

$$\theta = \tan^{-1}\frac{36}{32} = \boxed{48° \text{ S of W}}$$

42° W of S

Q 2



$$\Sigma P_{xi} = \Sigma P_{xf}$$

x: $0.8\,kg \times 2\,m/s = P_x + 0.4\,kg \times 1\,m/s \times \cos 30$

$$P_x = 1.254\,kg\,m/s$$

$$\Sigma P_{y_i} = \Sigma P_{y_f}$$

y: $0 = P_y + 0.4\,kg \times 1\,m/s \times \sin 30°$

$$P_y = 0.20\,kg\,m/s$$

$$P = \sqrt{P_x^2 + P_y^2} = \sqrt{1.245^2 + 0.2^2}$$

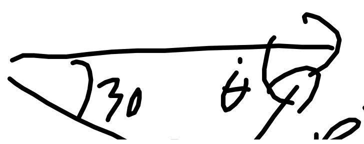
$$= 1.227\,kg\,m/s$$

$$v = \frac{P}{m} = \boxed{1.59\,m/s}$$

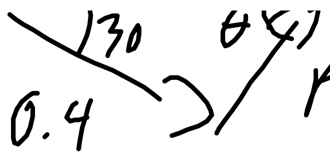
$$\theta = \tan^{-1} \frac{0.2}{1.245} = \boxed{9.1°}$$ from original direction

Alternate solution

1.6



$P^2 = 1.6^2 + 0.4^2 - 2(1.6)0.4\cos 30°$



$$p^2 = 1.6^2 + 0.4^2 - 2(1.6)0.4\cos 30$$

$$p = 1.245$$

$$\boxed{V = 1.54\,m/s}$$

$$\frac{\sin\theta}{0.4} = \frac{\sin 30}{1.245}$$

$$\boxed{\theta = 9.1^\circ}$$